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NAVAL POSTGRADUATE SCHOOL
Monterey, California

Master of Science in Software Engineering

Academic Program Manual

by

Luqi

July 2001

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Prepared for: Software Engineering Automation Center
Naval Postgraduate School
Monterey, CA 93943

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Monterey, California 93943-5000

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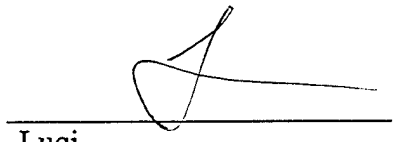

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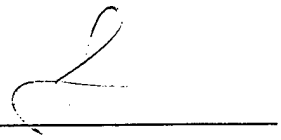

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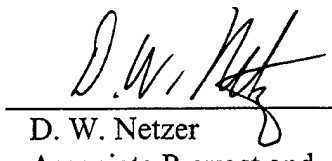

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13. ABSTRACT (Maximum 200 words)

This document contains the objectives, organization, policies and procedures for the Master of Science in Software Engineering degree program at the Naval Postgraduate School. It provides guidelines, templates, and procedures for the preparation and submission of the thesis proposal and the Master's thesis.

14. SUBJECT TERMS
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Section I

Description of the MS Software Engineering Program

MS Software Engineering Program

1. INTRODUCTION

The Software Engineering program at the U.S. Naval Postgraduate School provides military and government graduate students with an opportunity to learn all aspects of software development and the skills needed to efficiently and reliably plan and create large-scale software systems using the best available tools. These skills are essential for officers and civilians responsible for acquisition, development or maintenance of military software.

The program includes in-residence and distance learning MS and PhD degree programs, certificate programs, short courses, and laboratory support. The PhD program is the first-ever doctoral program in Software Engineering. The MS program offers four ways for students to earn a Master's degree: (1) MS Software Engineering Full-Time option, (2) MS Software Engineering Part-Time option, (3) MS Software Engineering with Combat Systems Sub-specialty option, and (4) MS Computer Science with Computer Science Sub-specialty option.

2. MASTER OF SCIENCE IN SOFTWARE ENGINEERING, FULL-TIME OPTION (369)

The MSSE offers a six-quarter, full-time curriculum with entry date in October, and an optional refresher quarter that starts in July. The program has built-in electives to allow military students to complete both intermediate level Navy Professional Military Education (PME) and Joint Professional Military Education (JPME) Phase I at NPS. For more information, visit our website at http://seac.nps.navy.mil or email your inquiries to se@cs.nps.navy.mil, or contact the Curricular Office at clapacik@nps.navy.mil.

2.1 Entry Requirements

Any military or civilian personnel sponsored by the U.S. Government, holding an accredited baccalaureate degree in one of the engineering disciplines, computer science, or related field, with above-average grades in mathematics, and at least one year of software development, maintenance, or acquisition experience are eligible to apply.

Application information for the MS degree in software Engineering can be found at: http://seac.nps.navy.mil.

2.2 Sample Course Matrix

MS Software Engineering

18 Month Curriculum for Military Students

Fall Input

Quarter 1 (Fall)	SW 3460 Software Methodology (3-1)	CS 3502 Computer Comms and Networks (4-0) / SW4555 Engineering of Network Centric Systems (3-1)	SW4582 Software Safety (3-1)	NW-3230 Strategy and Policy
Quarter 2 (Winter)	SW4500 Software Engineering (3-1)	W4580 Design of Embedded Real-Time Systems (3-0)	SW4591 Requirements Engineering (3-1)	NW-3210 NSDM: Directed Study Part I
Quarter 3 (Spring)	SW4520 Advanced Software Engineering (3-0)	S4300 Software Engineering and Management (3-2)	SW4590 Software Architecture (3-1)	NW-3211 NSDM: Directed Study Part II
Quarter 4 (Summer)	SW4540 Software Testing (3-1)	MN3309 Acquisition of Embedded Weapon Sys S/W (4-1) SW4581 Software Reliability & Quality Metrics (3-1)	SW4510 Computer Aided Prototyping (3-0) SW4530 Software R&D in DoD (3-1)	NW-3220 JMO: Directed Study Part I
Quarter 5 (Fall)	SW 0810 Thesis	SW 0810 Thesis	SW4570 Software Reuse (3-0) SW4592 Software Risk Assessment (3-1)	NW-3221 JMO: Directed Study Part II
Quarter 6 (Winter)	SW 0810 Thesis	SW 0810 Thesis	IS3171 Economic Evaluation of Information Systems II (4-1) EO4011 System Engineering for Acquisition Managers (3-2)	NW-3223 JMO: Directed Study Part I

This track is notional. Please see the Software Engineering Academic Associate regarding possible substitutions for track-specific classes to accommodate focus areas pertinent to your thesis research.

Students who have enough computer and programming background and have no special military requirements may have some of the courses waived and finish the study in four quarters based upon the course matrix shown below.

MS Software Engineering

12 Month Curriculum for Civilian Students

Fall Input

Quarter 1 (Fall)	SW 3460 Software Methodology (3-1)	CS 3502 Computer Comms and Networks (4-0) / SW4555 Engineering of Network Centric Systems (3-1)	SW4570 Software Reuse (3-0) / SW4592 Software Risk Assessment (3-1)	SW4582 Software Safety (3-1)
Quarter 2 (Winter)	SW4500 Software Engineering (3-1)	SW4580 Design of Embedded Real-Time Systems (3-0)	SW4591 Requirements Engineering (3-1)	SW0810 Thesis Research
Quarter 3 (Spring)	SW4520 Advanced Software Engineering (3-0)	IS4300 Software Engineering and Management (3-2)	IS3171 Economic Evaluation of Information Systems II (4-1) / EO4011 System Engineering for Acquisition Managers (3-2)	SW0810 Thesis Research
Quarter 4 (Summer)	SW4540 Software Testing (3-1)	SW4510 Computer Aided Prototyping (3-0) / SW4530 Software R&D in DoD (3-1) / SW4581 Software Reliability & Quality Metrics (3-1)	SW0810 Thesis Research	SW0810 Thesis Research

Note: This track is notional. Please see the Software Engineering Academic Associate regarding possible substitutions for track-specific classes to accommodate focus areas pertinent to your thesis research.

2.3 Degree Requirements

Students enrolled in the Software Engineering curriculum must complete the 12 courses approved by the program.

3. Master of Science in Software Engineering, Part-time Option (369)

This is a twelve-quarter, part-time curriculum with entry date in October. The program has enough flexibility for sponsors to tailor the elective courses to meet their special needs. For more information, visit our website at http://seac.nps.navy.mil or email your inquiries to se@cs.nps.navy.mil.

3.1 Entry Requirements

Any military or civilian personnel sponsored by the U.S. Government, holding an accredited bachelor's degree in one of the engineering disciplines, computer science, or related field, with above-average grades in mathematics, and at least one year of software development, maintenance, or acquisition experience is eligible to apply.

Application information for the MS degree in Software Engineering can be found at http://seac.nps.navy.mil.

3.2 Sample Course Matrix for Software Acquisition Track

MS Software Engineering

18 Month Curriculum for Military Students

Spring Input

Quarter 1 (Spring)	SW 3460 Software Methodology (3-1)	CS 3502 Computer Comms and Networks (4-0) / SW4555 Engineering of Network Centric Systems (3-1)	IS4300 Software Engineering and Management (3-2)	NW-3230 Strategy and Policy
Quarter 2 (Summer)	SW4500 Software Engineering (3-1)	SW4540 Software Testing (3-1)	MN3309 Acquisition of Embedded Weapon Sys S/W (4-1) / SW4581 Software Reliability & Quality Metrics (3-1)	NW-3210 NSDM: Directed Study Part I

MS Software Engineering, *(continued)*

18 Month Curriculum for Military Students

Spring Input

Quarter 3 (Fall)	SW4570 Software Reuse (3-0)	SW4582 Software Safety (3-1)	W4592 Software Risk Assessment (3-1)	NW-3211 NSDM: Directed Study Part II
Quarter 4 (Winter)	SW4580 Design of Embedded Real-Time Systems (3-0)	SW4591 Requirements Engineering (3-1)	IS3171 Economic Evaluation of Information Systems II (4-1) / EO4011 System Engineering for Acquisition Managers (3-2)	NW-3220 JMO: Directed Study Part I
Quarter 5 (Spring)	SW 0810 Thesis	SW 0810 Thesis	SW4520 Advanced Software Engineering (3-0)	NW-3221 JMO: Directed Study Part II
Quarter 6 (Summer)	SW 0810 Thesis	SW 0810 Thesis	SW4510 Computer Aided Prototyping (3-0) / SW4530 Software R&D in DoD (3-1)	NW-3223 JMO: Directed Study Part I

Note: This track is notional. Please see the Software Engineering Academic Associate regarding possible substitutions for track-specific classes to accommodate focus areas pertinent to your thesis research.

3.3 Degree Requirements

Students enrolled in the Software Engineering curriculum must complete the twelve courses approved by the Software Engineering Academic Associate. Completion of a master's thesis is required.

3.4 Distance Learning Equipment Specifications

Students participate in the distance Learning Program via our PictureTel 4000 Video Teleconferencing Systems using Integrated Services digital Network, Basic Rate Interface (ISDN RI) lines. This set-up allows two-way, interactive audio and video between distant sites and an NPS classroom. The students' site must have a standards-based (H.320-compatible) connection to a dial-up network (FTS2000).

Commercial networks may be used when FTS2000 is not available. NPS uses AT&T Accunet for commercial calls. NPS is currently establishing a program to lease VTC equipment to remote sites in order to provide the highest degree of compatibility and fidelity that the technology offers.

4. MASTER OF SCIENCE IN SOFTWARE ENGINEERING, COMBAT SYSTEMS SUBSPECIALTY OPTION (533)

The Combat Systems Sub-specialty MSSE is an eight-quarter curriculum with entry dates in January and July. This is a systems engineering program with an emphasis on computer-based systems and DoD applications. This program is designed to meet Navy needs that go beyond software to treat whole system issues. If further information is needed, contact the Curricular Officer or the Academic Associate.

4.1 Entry Requirements

A baccalaureate degree with mathematics through differential and integral calculus and a calculus-based physics sequence are required for direct input. Courses in the physical sciences and engineering are highly desirable. Officers not having the required qualifications for direct input enter the program through the Engineering Science (460) Curriculum. An APC of 323 is required.

4.2 Sample Course Matrix

MS Software Engineering

Course Matrix for Students Entering in Summer

Quarter 1 (Summer)	PH1121 Mechanics I	MA1995 Math Methods I	MA1996 Math Methods II	NW3230 Strategy & Policy: The American Experience
Quarter 2 (Fall)	PH1322 E&MI	PH2151 Mechanics II	PH3991 Theoretical Physics	SW3460 Software Methodology
Quarter 3 (Winter)	PH1623 Modern Physics I	PH2351 E&M II	SE2013 Analog Techniques & Communications	SW4500 Software Engineering
Quarter 4 (Spring)	PH3352 E&MIII	PH3652 Modern Physics II	SE2014 Digital Techniques	SW4520 Advanced Software Engineering
Quarter 5 (Summer)	PH3292 Physics Optics	SE3015 Autonomous Combat Systems Design	SW 4510 Computer Aided Prototyping	SW4540 Software Testing
Quarter 6 (Fall)	SE3172 Physics of Weapon Systems	SW4592 Software Risk Assessment	SW4520 Software Engineering R&D in DoD	SW0810 Thesis Research
Quarter 7 (Winter)	SE3400 Physics of Sonar Systems	SW4580 Design of Embedded Real Time Systems	SW4591 Requirements Engineering	SW0810 Thesis Research
Quarter 8 (Spring)	SE4050 Physics of E&M Sensors	SE4860 Advanced Weapons Concepts	SW0810 Thesis Research	SW0810 Thesis Research

This track is notional. Please see the Software Engineering Weapon Systems regarding possible substitutions for track-specific classes to accommodate focus areas pertinent to your thesis research.

4.3 Degree Requirements

Students enrolled in the Combat Systems Sub-specialty MSSE curriculum must complete the 28 above listed courses. Completion of a master's thesis is required.

5. MASTER OF SCIENCE IN COMPUTER SCIENCE, COMPUTER SCIENCE SUBSPECIALTY OPTION (368)

The Computer Science curriculum is designed to provide the student with the technical knowledge and skills necessary to specify, evaluate and manage computer system design; provide technical guidance in applications ranging from data processing to tactical embedded systems; educate the student in the analysis and design methodologies appropriate for hardware, software and firmware; and provide the student with practical experience in applying modern computer equipment and research techniques to solve military problems.

The purposes of the Software Engineering track are to provide knowledge of all aspects of software development and to develop skills needed to efficiently and reliably implement military systems and application software using the best available tools and techniques.

The MSCS is an eight-quarter course of study with entry dates in April and October. Those requiring the six- or twelve-week refresher will begin study prior to those entry dates. If further information is needed, contact the Academic Associate of Curricular Officer.

For more information, visit our website at http://seac.nps.navy.mil, or email your inquiries to se@cs.nps.navy.mil, or contact the Curricular Officer at clapacik@nps.navy.mil.

5.1 Entry Requirements

A baccalaureate degree or the equivalent with above-average grades in mathematics (including differential and integral calculus), resulting in an APC of at least 325 is required for direct entry. Undergraduate degrees in applied science or engineering are highly desirable. Students lacking these prerequisites may be acceptable for the program through a six- or twelve-week refresher course, providing their undergraduate records and/or other indicators of success, such as the Graduate Record Examination (GRE) indicate an ability to work in quantitative subjects. While previous academic or practical experience in computer science is certainly helpful and can enhance the applicant's potential for admission, such experience is not a prerequisite.

5.2 Sample Course Matrix

MS Computer Science
Software Engineering Track

18 Month Curriculum for URL Students (CS Undergrad)

Fall Input

Quarter 1 (Fall)	CS 377X Second Language (4-2)	CS 3502 Computer Comms and Networks (4-0)	SW 3460 Software Methodology (3-1)	NW-3230 Strategy and Policy
Quarter 2 (Winter)	SW4500 Software Engineering (3-1)	SW4580 Design of Embedded Real-Time Systems (3-0)	SW4591 Requirements Engineering (3-1)	NW-3210 NSDM: Directed Study Part I
Quarter 3 (Spring)	CS 3310 Artificial Intelligence (4-1)	SW4520 Advanced Software Engineering (3-0)	SW4590 Software Architecture (3-1)	NW-3211 NSDM: Directed Study Part II
Quarter 4 (Summer)	SW4510 Computer Aided Prototyping (3-0) / SW4530 Software R&D in DoD (3-1)	SW4540 Software Testing (3-1) / SW4581 Software Reliability & Quality Metrics (3-1)	CS 3320 Database Systems (3-1)	NW-3220 JMO: Directed Study Part I
Quarter 5 (Fall)	CS 0810 Thesis	CS 0810 Thesis	CS 3600 Intro Computer Security (4-2)	NW-3221 JMO: Directed Study Part II
Quarter 6 (Winter)	CS 0810 Thesis	CS 0810 Thesis	MV 4203 Interactive Computation Systems (3-2)	NW-3223 JMO: Directed Study Part I

This track is notional. Please see the Software Engineering Academic Associate regarding possible substitutions for track-specific classes to accommodate focus areas pertinent to your thesis research.

5.3 Degree Requirements

Students enrolled in the MSCS/Software Engineering track must successfully complete the 7 general Computer Science courses plus 7 advanced Software Engineering courses. Completion of research leading to a master's thesis is required.

6. ADMISSION PROCEDURES

The point of contact to request Naval Postgraduate School catalogs and admission to all degree programs is:

Director of Admissions
Code 01B3, Naval Postgraduate School
589 Dyer Rd, RM 103C
Monterey, CA 93943-5100
Telephone: (831) 656-3093
DSN: 878-3093
FAX: (831) 656-2891

Application information for the MS degree in Software Engineering can be found at:

http://seac.nps.navy.mil.

II. QUARTERLY COURSE PRE-REGISTRATION PROCEDURE FOR DISTANCE LEARNING CLASSES

1. In the first week of each quarter, the Software Engineering staff provides POCs at remote sites with the list of distance learning courses (course number, catalog description, instructor, lecture time). Remind POCs to have students fill out the Registration Information Sheet for Distance Learning Students form (Appendix 1) if taking NPS courses for the first time.

2. POCs at remote sites submit class lists to the Software Engineering office (seac_ms@cs.nps.navy.mil) via email no later than Friday of the third week.

3. Software engineering staff forwards the class lists to the Assistant Registrar (mscheffel@nps.navy.mil) vial email.

4. The MSSE coordinator forwards the list of distance learning courses and their lecture hours to the Scheduler (cwilson@nps.navy.mil) by Friday the fourth week.

5. The MSSE coordinator forwards VTC requirements to the Distance Learning Coordinator (dswalsh@npslnavy.mil) by Friday of the fourth week.

III. QUARTERLY STUDENT OPINION FORM (SOF) PROCEDURE FOR DISTANCE LEARNING CLASSES

1. Software Engineering staff obtains SOF packages from the Scheduler (cwilson@nps.navy.mil) by Friday of the seventh week of each quarter.

2. Software Engineering staff asks the instructors to fill out the cover sheets.

3. Software Engineering staff mails the SOF packages (together with the instructions shown in Appendix 2) to the POCs at remote sites, asking them to have the distance learning students fill out the SOFs and return the packages to the Software Engineering office by Monday of the eleventh week.

4. Software Engineering staff sends reminder via email to the POCs at remote sites if he/she has not received the SOFs by Monday of the twelfth week.

5. Software engineering staff forwards the SOFs to the Scheduler (cwilson@nps.navy.mil) by Friday of the thirteenth week.

IV. QUARTERLY THESIS SUBMISSION PROCEDURE FOR DISTANCE LEARNING STUDENTS

1. The first week of each quarter, Software Engineering staff notifies POCs at remote sites to submit the list of graduates (and their official names, postal address for diploma, thesis advisor, thesis title, and whether or not they will attend graduation ceremonies) in that quarter.

2. By the end of the second week, POCs at remote sites submit a list of those students graduating that quarter (and their information) to the Software Engineering office (seac_ms@cs.nps.navy.mil).

3. Software Engineering staff forwards the graduation list and information to the Code 32 curricular office [jbrennan@nps.navy.mil, (831) 656-4679].

4. Software Engineering staff forwards the following attachments to the graduating students:

- Class checklist.
- Thesis preparation/distribution form
- Research information form
- Thesis Release Memo (thesis publication on the thesis web site)
- Sample thesis pages

5. By the end of the sixth week, graduating students must send thesis draft to the thesis processor for format check and incorporate the comments into the thesis draft:

Ms. Elaine Christian, Code 91/Ec
Room Ha-236
Naval Postgraduate School
Monterey, CA 93943-5138
Phone: (831) 656-1124
Email: echristian@nps.navy.mil

6. By the end of the seventh week, graduating students send thesis draft to advisors and second readers for content check.

7. By the end of the eighth week, thesis advisors will inform the Software Engineering office (seac_ms@cs.nps.navy.mil) via email if they find the thesis content acceptable for graduation. The Software Engineering staff will withdraw students from the graduation list (via email to Ms. Jean Brennan at the Code 32 curricular office) if their advisors have not sent approval to the Software Engineering office by the end of the eighth week.

8. By the end of the ninth week, graduating students must incorporate all the changes from their advisors and second readers and send the thesis draft to the thesis processor for a second format check.

9. By the end of the tenth week, graduating students must incorporate any changes required by the thesis processor and submit the final thesis to the NPS Software Engineering office.

- Student signs the signature page.

- If the thesis involves a co-advisor or second reader at a remote site, ask them to sign the thesis.

- Send three copies of the thesis, together with the thesis classification form, thesis advisor information sheet, thesis release memo, and a floppy disk containing the special abstract to the advisor at NPS for signature.

- Email an on-line copy of the thesis to the Software Engineering office (seac_ms@cs.nps.navy.mil).

- Ask the advisor to forward the signed thesis, floppy disk, etc. to the Software Engineering office.

- The Software Engineering staff will obtain the signature of of the Software Engineering curriculum chair and then forward the thesis to the thesis processor.

- The Software Engineering staff will notify the student via email once the thesis processor has accepted the thesis.

10. Graduating students who attend the graduation commencement should arrive at NPS in the morning of the day before graduation commencement, get nametags from Ms. Jean Brennan [SP-404, (831) 656-4679, jbrennan@nps.navy.mi], and attend commencement rehearsal at 1300 hours on the day before graduation (usually on the Wednesday of the twelfth week).

V. THESIS PROPOSAL SUBMISSION PROCEDURE FOR DISTANCE LEARNING STUDENTS

1. The Software Engineering staff requests MS thesis topics from all Software Engineering faculty two weeks before the end of the quarter when distance learning thesis students register for SW0810 for the first time in their MSSE study.

6. The Software Engineering staff sends the thesis guidelines, thesis procedures (from the MSSE Handbook), sample thesis proposal, and the list of thesis topics to the POCs at remote sites via email no later than Friday of the week before the end of the quarter. POCs at the remote sites forward the information to the thesis students.

7. The MSSE coordinator schedules a VTC meeting during the first week of the quarter to go over the thesis guidelines, thesis procedures, sample thesis proposal and the thesis topics with the distance learning students.

8. Thesis students study the list of thesis topics and discuss the topics with their potential advisors via email, audio phone, and individual VTC sessions.

9. By the end of the eighth week, thesis students must send a thesis proposal draft to their advisor and second reader for comments.

10. By the end of the tenth week, thesis students must incorporate all changes required by their advisors and second readers and submit the final thesis proposal to the NPS Software Engineering office (seac_ms@cs.nps.navy.mil).

- Student signs the thesis proposal.
- If the thesis involves a co-advisor or second reader at a remote site, ask them to sign the proposal.
- Send a copy of the thesis proposal to the advisor at NPS for signature.
- Email an on-line copy of the thesis proposal to the Software Engineering office (seac_MS@cs.nps.navy.mil).
- Ask the advisor to forward the signed thesis proposal to the Software Engineering office.
- The Software Engineering staff will obtain the signature of the Software engineering Curriculum Chair and then forward the thesis proposal to Ms. Jean Brennan (jbrennan@nps.navy.mil) at the Code 32 curricular office.

Section II

Appendices

NAVAL POSTGRADUATE SCHOOL
OFFICE OF THE REGISTRAR
CODE 01B1, 589 DYER ROAD
MONTEREY, CA 93943
REGISTRAR INFORMATION SHEET
DISTANCE LEARNING

(Please Print Legibly)

Last Name First Middle Social Security Number

Rank/Grade_____
Service_____
Degree Program (yes or no) _____
Curriculum number _____
Email Address _____
Site/Location_____
Course #_____
Course Start Date_____

NAME OF SCHOOLS WHERE YOU WERE AWARDED DEGREES:

EXAMPLE: California State Univ. San Jose, CA BA/BS /Political Science 1995

Name of Institution, State Awarded | Degree Received/Major | Year

Name of Institution, State Awarded | Degree Received/Major | Year

Under the authority of 5 USC 301, the above information is to become a permanent part of your student record. The information provided will not be divulged without your written authorization to any one other than for official business with the appropriate agencies of your country or service.

SIGNATURE_____ **DATE**_____

(831) 656-2591, DSN 878-2591, FAX x2891
mscheffel@nps.navy.mil

12 March 2001

SOF Instructions

Enclosed please find the instructions and cover sheets for the [course #] SOFs. Please have the students fill out their SOFs and return the surveys to:

Software Engineering Admin Office
Naval Postgraduate School
833 Dyer Road, Room SP531
Monterey, CA 93943
(831) 656-4091

Remember to answer the following additional questions:

17. The quality of distance learning instruction compares favorably to the instructions received in a standard class.

18. The equality of course material covered by distance learning methods is equivalent to that in a standard class.

19. Interactions between students and the instructor in a distance learning environment have comparable instructional value as in a standard classroom setting.

20. Overall, the content of a course is more important than the technology used for its delivery.

SOFTWARE ENGINEERING THESIS PROPOSAL COVER PAGE

[Date]

MEMORANDUM

From: Student's Name

To: Curricular Officer, Code 32
Via: (1) Thesis Advisor: Advisor's Name
(2) Chair, Software Engineering Curriculum: Dr. Luqi

Subj: Thesis Proposal

Encl: (1) Milestone Plan for research and thesis completion.

1. Tentative Title of Proposed Thesis:

Development of a software evolution process for military systems composed of integrated commercial off the shelf (cots) components.

2. General Area of Proposed Thesis Research:

Factors Affecting Government Software Evolution Management of Military Systems Composed of Commercial Off-the-Shelf (COTS) Software Components.

3. Enclosure (1) is a milestone plan (dates/events) for research and thesis completion.

4. I expect that my thesis will be unclassified.

5. We anticipate the following travel or other extraordinary requirements: None

6. Proposed Second Reader: Second Reader's Name

7. Second Reader's Signature: _____
Second Reader

_____
Student Signature

1. Approved and forwarded _____ _____
Thesis Advisor Date

2. Approved and forwarded _____ _____
Chair, Software Engineering Curriculum Date

3. Approved and forwarded _____ _____
Curricular Officer, Code 32 Date

SAMPLE THESIS PROPOSAL

A GENERAL INFORMATION

1. Name: Your Name
2. Curriculum: Software Engineering (369)
3. Thesis Advisor: Advisor's Name
4. Second Reader: Second Reader's Name

B AREA OF RESEARCH

Factors Affecting Government Software Evolution Management of Military Systems Composed of Commercial Off-the-Shelf (COTS) Software Components. Topics of interest include software requirements management, software configuration control, software test & evaluation, and software risk management.

C RESEARCH QUESTIONS

PRIMARY

1. Do traditional software evolution models support systems composed of COTS software components?

SECONDARY

2. How does a Government Software Support Activity (SSA) manage system requirements when it does not control component source code?

3. How does a Government SSA maintain system configuration control when it does not control version release dates?

D DISCUSSION

The current trend in Department of Defense (DoD) acquisition policy is to make maximum effective use of COTS software components during system development. Traditional software evolution activities (i.e., those activities that occur after delivery of a software product to the fleet) typically consist of correcting software errors, adding new capabilities (enhancements), and adapting the software product to new environments. These traditional activities require maintainer access to and complete control over system source code. For systems that employ COTS software components, maintainers lose direct access to product source code.

A new software evolution model must therefore be developed to address executable vice source code management.

E SCOPE OF THESIS

The main thrust of this thesis is to propose a new over-arching software evolution model for military systems that employ COTS software components. Specifically, the thesis will explore the software requirements analysis and the software configuration control aspects of the new model. For requirements analysis: the thesis will propose a multiple criteria decision model to aid the COTS software component selection/upgrade process. The model, based on the Electre method, will assess tangible and intangible COTS component costs and benefits. For configuration control: the thesis will evaluate the relational hypergraph model as a tool to aid COTS software component tracking. This thesis is limited to software evolution activities and excludes software development activities.

F METHODOLOGY

This thesis will propose a new software evolution model for military systems that employ COTS software components. The general research methodology will include theoretical analysis of traditional software evolution methodologies, identification of COTS specific issues and concerns, and development of engineering processes to address extant methodology shortcomings. Real-world case studies and sidebars will supplement thesis conclusions. Case studies and sidebars will be drawn from various Department of Navy (DoN) Meteorological and Oceanographic (METOC) programs:

- The Tactical Environmental Support System (TESS) is an METOC legacy system that consists of approximately 2.5 million lines of source code.

- The Navy Integrated Tactical Environmental System (NITES), slated to replace TESS in late fiscal year 1999, is built around COTS software components.

The push to employ COTS software components in new military system developments is a recent DoD trend. Validation and verification of thesis conclusions will therefore require further analysis after this development strategy matures.

G CHAPTER OUTLINE

IIntroduction

Background
- Policy: DoD push to use COTS software components

Software Evolution Management

- Traditional Evolution Models: issues and concerns
- Proposed Evolution Model: Military Systems composed of COTS Components

Software Requirements Analysis

- COTS Component Investment: Multiple Criteria Decision Model (Electre Method)

Software Configuration Control

- COTS Component Tacking: Activity Based Model (Relational Hypergraph Model)

Conclusions

Appendices

Bibliography

H. SCHEDULE

1.	Literature Review:	15 Jun – 30 Jun
2.	Conduct Research:	01 Jul – 30 Jul
3.	Develop Draft Thesis:	01 Aug– 30 Sep
4.	Draft Thesis for Review:	01 Oct
5.	Final Thesis for Submission:	01 Nov

I BENEFITS OF STUDY

There is a strong misconception among Government program managers that COTS software components provide an easy solution to software life-cycle cost and schedule overruns. The main benefits of this thesis are to address some of the problems associated with COTS software intensive systems and to propose possible software engineering solutions to those problems.

J ANTICIPATED TRAVEL/FUNDING REQUIREMENTS

None.

K. PRELIMINARY BIBLIOGRAPHY

Federal Acquisition Regulation (FAR) – various parts (TBD) that promote COTS procurement as the primary acquisition method.

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ABSTRACT

Department of Defense (DoD) acquisition policy requires that military system acquisitions incorporate commercial-off-the-shelf (COTS) components into system architectures. Traditional DoD source code development and evolution methodologies do not effectively support COTS-intensive systems. To fully realize the benefits of COTS technologies and products, the DoD must adopt new ways to sustain system evolution in the face of a dynamic market environment subject to constant change.

This thesis proposes a new software evolution methodology to effectively maintain COTS-intensive military systems. The integrated COTS component evolution (ICCE) model provides evolution processes designed to support the maintainer as a consumer of software instead of a source-code developer. The ICCE model affords proactive risk awareness, market awareness, and user awareness activities. The ICCE model also supports a three-tier test and evaluation process. A case study for the U.S. Navy/Marine Corps Meteorological Mobile Facility Replacement (METMF(R)) program demonstrates the effectiveness of the ICCE risk management process.

ACKNOWLEGEMENT

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INTRODUCTION

SUMMARY

Department of Defense (DoD) acquisition policy requires that military system acquisitions incorporate commercial-off-the-shelf (COTS) components into system architectures. Traditional DoD source code development and evolution methodologies do not effectively support COTS-intensive systems. To fully realize the benefits of COTS technologies and products, the DoD must adopt new ways to sustain system evolution in the face of a dynamic market environment subject to constant change.

This thesis proposes a new software evolution methodology to effectively maintain COTS-intensive military systems. The integrated COTS component evolution (ICCE) model provides evolution processes designed to support the maintainer as a consumer of software instead of a source-code developer. The ICCE model affords proactive risk awareness, market awareness, and user awareness activities. The ICCE model also supports a three-tier test and evaluation process. A case study for the U.S. Navy/Marine Corps Meteorological Mobile Facility Replacement (METMF(R)) program demonstrates the effectiveness of the ICCE risk management process.

PURPOSE

The Department of Defense (DoD) is undergoing a significant change in the way it acquires and maintains software intensive systems. To alleviate software development costs and reduce schedule delays, the DoD is shifting towards the commercial market to fulfill system requirements.

The primary purpose of this thesis is to:

- Develop a new software evolution methodology that supports the DoD maintainer as a consumer of software instead of a source code developer.

The secondary purpose of this thesis is to:

- Develop and demonstrate a risk management process for military systems built around an integrated software component solution.

- Develop a formal qualification test and evaluation process for military systems built around an integrated software component solution.

MOTIVATION

Acquisition managers must understand that choosing a COTS component may be a reasonable solution; however, the decision to use COTS should be the product of analysis, reasoning, and engineering decisions, not the desire to jump on the latest bandwagon. [Ref. 1]

Even though Brooks [Ref. 2] warned that silver bullets do not exist to solve software development and maintenance productivity problems, the DoD is pushing the commercial market as a silver bullet to reduce military system development costs and to mitigate schedule delays.

A review of software management and engineering literature illustrates some of the following expectations and realities that exist regarding the integration of COTS software components into military systems. Some of the expectations include:

- COTS software components will reduce development costs and overall schedule [Ref. 3].
- COTS software components are less risky [Ref. 4].
- COTS software components can be procured and modified faster and cheaper than developing the component from scratch [Ref. 4].
- COTS software components will satisfy all system requirements [Ref. 4].
- COTS software components are stable and error-free [Ref. 4].
- COTS components do not require testing [Ref. 5].
- COTS components are selected based on extensive evaluation and analysis [Ref. 5].
- Vendors will keep the component current and up to date with technology [Ref. 4].
- Vendors will utilize commercially accepted interface standards.
- Vendors will employ commercially accepted software engineering development practices.
- Vendor literature is accurate, complete and understandable [Ref. 4].

- An open-system architecture solves the COTS component inter-operability problem [Ref. 5].

Some of the realities include:

- COTS software component integration can be expensive [Ref. 4].
- COTS software components require more testing because the integrator does not know how they were built [Ref. 5].
- COTS software components are typically selected based on slick demos, web searches, or by reading trade journals [Ref. 5].
- Selecting the wrong COTS component can be more expensive than fixing problems in custom-built software [Ref. 4].
- COTS software component vendors do not supply all services [Ref. 4].
- Features sell COTS components, not documentation [Ref. 5].
- COTS software components may not meet all the system requirements [Ref. 4].
- COTS software components may not be easy to modify [Ref. 4].
- The system developer will have little control over vendor quality and schedule [Ref. 4].
- The system developer's organization will have to change to accommodate COTS software components [Ref. 4].
- There is no standard definition for open-system and plug-and-play does not always work [Ref. 5].
- COTS software components introduce new tradeoffs, issues, constraints, assumptions, problems, and inadequacies [Ref. 1, 3, 5, 6, 7].

The large-scale integration of COTS software components into military system architectures introduces new engineering, management, and organization challenges:

- The system maintainer no longer controls software component specification.

- The system maintainer no longer controls software component source code.
- The system maintainer no longer controls software component release schedule.
- The system maintainer is no longer able to conduct developmental (white box) test and evaluation.

The purpose of software engineering is to improve the quality of software and software products [Ref. 8]. The primary motivation behind this thesis is to help DoD managers acquire and maintain effective COTS-intensive military systems. Specifically, this paper will attempt to convey the following essential points:

- DoD managers and engineers must have a clear understanding of the applicable risks and benefits associated with COTS-intensive system acquisitions.
- DoD managers and engineers must adopt new processes and activities to sustain effective COTS-intensive systems.

ORGANIZATION

This thesis is organized into the following chapters:

- Chapter II identifies acquisition source documents and policy statements affecting the DoD push toward COTS integration into military systems.
- Chapter III provides a brief overview of traditional source code-based development and evolution activities.
- Chapter IV presents the integrated COTS component evolution (ICCE) model along with a brief overview of the major ICCE activities and processes.
- Chapter V presents the ICCE risk management process for COTS-intensive systems.
- Chapter VI presents a case study that demonstrates the effectiveness of the ICCE risk management process.
- Chapter VII presents the ICCE test and evaluation process for COTS-intensive systems.
- Chapter VIII provides thesis conclusions and recommendations.

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(3) National command authorities and command posts.

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Part VI. CRITICAL TECHNOLOGY AREAS LISTINGS

(Please check all that apply to your thesis work)

Joint Warfighting Science and Technology Plan Defense Technology Objectives:

_____ Information Superiority
_____ Precision Fires
_____ Combat Identification
_____ Joint Theater Missile Defense
_____ Military Operations on Urbanized Terrain
_____ Joint Readiness and Logistics and Sustainment of Strategic Systems
_____ Force Projection/Dominant Maneuver
_____ Electronic Warfare
_____ Chemical/Biological Warfare Defense and Protection and Counter
_____ Weapons of Mass Destruction
_____ Combating Terrorism
_____ Protection of Space Assets

Defense Technology Area Plan Defense Technology Objectives:

_____ Air Platforms
_____ Chemical/Biological Defense
_____ Information Systems Technology
_____ Ground and Sea Vehicles
_____ Materials/Processes
_____ Biomedical
_____ Sensors, Electronics, and Electronic Warfare
_____ Space Platforms
_____ Human Systems
_____ Weapons
_____ Nuclear Technology
_____ Battlespace Environments

Command Capability Issues:

____ **Battlespace Connectivity**
_____ Flexible Targeting
_____ Mine Warfare (Offensive and Defensive)
_____ Common/Consistent Tactical Picture
_____ Ship Self Defense/Force Protection
_____ Chemical/Biological Defense
_____ Coalition C4I
_____ Interdiction Operations, Sanctions Enforcement, and Counter-SOF
_____ Maintenance
_____ Information Warfare and Counter-GPS Jamming
_____ Integrated Fire Support
_____ Non-lethal Technologies
_____ Over-the-Horizon Sustainment and Resupply

_____ Shallow Water ASW
_____ Theater Air Defense
_____ Fight in Adverse Environmental Conditions
_____ Simulation and Training
_____ Unmanned Tactical Reconnaissance

Future Naval Capabilities:
_____ Autonomous Operations
_____ Capable Manpower
_____ Electric Ship and Combat Vehicles
_____ Knowledge Superiority and Assurance
_____ Littoral ASW
_____ Littoral Combat and Power Projection
_____ Missile Defense
_____ Organic Mine Countermeasures
_____ Platform Protection
_____ Time Critical Strike
_____ Total Ownership Cost Reduction
_____ Warfighter Protection

THESIS EXTENSION REQUEST

DATE: _____

FROM: _____
Last Name First Name M.I. Rank Service Country

ADDRESS: _____
_____

To: Academic Council (Code 01B)

Via: (1) _____, Thesis Advisor
(2) _____, Academic Associate
(3) _____, Department Chairmen
(4) _____, Curricular Officer

Subj: _____REQUEST FOR THESIS EXTENSION
(1st, 2nd, or 3rd)

1. I request a _____year extension until _____ to complete the thesis requirements
(1st, 2nd, or 3rd) Month/Year

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Month/Year

2. I understand that *I am solely responsible* for filing my own timely thesis extension and upon successful completion of my thesis, I will notify the Curricular Office. I understand the Curricular Officer will re-nominate me for my degree and make preliminary arrangements for my diploma to be printed. Upon approval of the degree award by the Academic Council and the Superintendent, my official graduation date will be the effective date of the next graduation ceremony. I will provide the Curricular Office with the mailing address for my diploma.

3. My justification for requesting a _____extension is as follows:
(2nd, or 3rd)

_____
_____
_____

_____
(Signature)

Revised 03/24/99

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To: Director of Admissions, Code 01B3
Naval Postgraduate School
589 Dyer Rd., RM 103C
Monterey, CA 93943-5100

From: Student's name
Student's contact info

Date: Enter date here

Subj: Admission to the MS Software Engineering (369) Program

I am presently employed as (position) at (command name) in (location). I request to for admission into the Master of Science in Software Engineering (369) under the distance learning option.

Enclosed please find the transcripts of my previous undergraduate and postgraduate work, and a copy of the authorization letter (or form, whichever is more appropriate) from my command.

Sincerely,

_____

Your name
Your title

MSSE Distance Learning POCs

SPAWAR Systems Center, San Diego:
VTC and Admin: Dr. David Lambert, lambert@spaware.navy.mil

SPAWAR Headquarters:
VTC and Admin: Capt. Jennifer Warwick, warwickj@spawar.navy.mil

TACOM:
VTC and Admin: Mr. Jack Wallace, wallacej@tacom.army.mil
VTC Alternate: Mr. Chris Klein, kleinc@tacom.army.mil

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